Prioritized Technology: Small Satellites
Electrical Power, Batteries, Deployable Structures

Technical Goal

Reliable radiation-hardened electrical power systems and power storage for CubeSats and small satellite platforms capable of operating in Venus, Moon, Asteroids/NEOs (Small bodies), Ice Bodies/Ocean Worlds/Outer Planets, and Mars environments. Provide power systems with thermal management system commensurate with the respective operational environment. Modular power systems with effective thermal control systems may include properly sized deployable/retractable solar arrays, power supplies, and batteries for operations for the following destinations; note, all performance parameters are notional:

Venus: Power systems and Wind powered rechargeable batteries for 10kg Probe that can be operational in high temperature and high pressure (460C, 92 bar) in low-intensity, corrosive environment with Mission life up to 1 year. Deployable 130W SA on 12U bus for up to 5 years mission life and 300W SA on ESPA class spacecraft with 5 year transport and 2 year Mission life.
Moon: 12U, 90W SA , batteries (74WHr Li), 2 year mission life, up to 30krad Radiation tolerance (TBC). ESPA Class 1kW SA.
Mars: 6U 18.5W@5AU (or 500W BOL SA @1AU). Batteries 120WHr. 60W SA @ Mars up to 100 kRad Radiation tolerance and 4 Year mission life. 12U 712W BOL @ 1AU (186W@Mars)
Asteroid: 6U spacecraft 300W@1AU BOL Solar Array
Icy Bodies: Power systems for ESPA size spacecraft for up to 8 year mission life, Solar cells that are optimized for low-intensity, low-temperture performance to provide peak power up to 7.5kW@1AU or 212W@Jupiter. Low temperature (230K) and high radiation operational environment (3 Mrads) for batteries (50Ah) and control electronics.

Technical Status

- Primary cells are currently limited to -40°C to -80°C discharge temperatures at ~100 to 200 Wh/kg, and secondary (rechargeable) cells are limited to 100-150 Wh/kg at -30°C.
- No batteries exist that can operate for days (or weeks) under the environmental conditions at the Venus surface. Several are under development under HOTTech and LLISSE, both primary and secondary. High temperature Li/FeS and Li/FeS2 rechargeable batteries were developed to a high TRL in the 1980s for terrestrial applications, but were never brought to market.

Mission Applications

Examples of applications include:
Venus: extended exploration (atmospheric and surface) for up to 1 year vs 2 hours with current technology.
Moon: multi-point mapping of lunar surface to understand lunar evolution.
Mars: multi-point, simultaneous measurements of Mars environment; observing the Martian environment over a Martian year, furthering knowledge of Mars' composition, temperature, ion escape/sputtering.
Small Bodies: constellations of probes to multiple small bodies or probes utilized to "point and stare" at a specific small body target.
Icy Bodies/Outer Planets/Ocean Worlds: exploration of outer worlds such as Uranus via Probes or provide multipoint measurements to investigate modes of solar wind coupling in Jupiter as well as neutral atoms escape.